

We claim:

1. A dental matrix resin, comprising the mixture of:
 - (a) a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane;
 - (b) a dioxirane; and
 - (c) an initiator capable of initiating cationic polymerization of said resin.
2. The resin of claim 1, wherein said initiator is a photoinitiator.
3. The resin of claim 2, wherein said photoinitiator is selected from the group consisting of (4-n-octyloxyphenyl)phenyliodonium hexafluoroantimonate, [4-(2-hydroxytetradecyloxyphenyl)]phenyliodonium hexafluoroantimonate, [4-(1-methylethyl)phenyl](4-methylphenyl)iodonium tetrakis(pentafluorophenyl)borate(1-), and combinations thereof.
4. The resin of claim 1, wherein said dioxiranyl tetraoxaspiro[5.5]undecane is selected from the group consisting of 3,9-bis(cyclohex-3-enylmethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis(cyclohex-3-enylmethoxy)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[2-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[7-bis(cyclohex-3-enyloxymethyl)-1,5,7,11-tetraoxaspiro{5.5}undecane, 3,9-bis[(6-oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-

oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, [16] 8,10,19,20-tetraoxatrispiro[5.2.2.5.2.2]henicosa-2,14-diene, 7,26-dioxatrispiro[bicyclo[4.1.0]heptane-3,5'-1,3-dioxane-2'2''-1,3-dioxane-5'',4'''-bicyclo[4.1.0]heptane], and combinations thereof.

5. The resin of claim 1, wherein said dioxirane is selected from the group consisting of diglycidyl ether bisphenol A, 3',4'-epoxycyclohexanemethyl-3,4-epoxycyclohexane carboxylate, bis(2,3-oxiranylcyclopentyl)ether, butanediol diglycidyl ether, bis(3,4-epoxycyclohexylmethyl) adipate, and combinations thereof.

6. The resin of claim 1, further comprising:
a polyol.

7. The resin of claim 6, wherein said polyol is selected from the group consisting of poly(tetrahydrofuran), 2-oxepanone polymer with 2-ethyl-2-(hydroxymethyl)-1,3-propane diol, and combinations thereof.

8. The resin of claim 1, further comprising:
a photosensitizer.

9. The resin of claim 8, wherein said photosensitizer is selected from the group consisting of camphorquinone, 2-chlorothioxanthen-9-one, and combinations thereof.

10. The resin of claim 1, further comprising:
a reaction promoter.

11. The resin of claim 10, wherein said reaction promoter is selected from the group consisting of ethyl p-dimethylaminobenzoate, 4,4'-bis(diethylamino)benzophenone, and combinations thereof.

12. The resin of claim 1, wherein said resin comprises about 1-30 weight % of said dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane, about 70-99 weight % of said dioxirane, and about 0.1-10 weight % of said initiator.

13. A dental restorative material, comprising the mixture of:

- (a) a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane;
- (b) a dioxirane;
- (c) an initiator capable of initiating cationic polymerization; and
- (d) a dental filler that does not substantially interfere with cationic polymerization.

14. A method of making a dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane,

comprising:

providing an alkyl substituted unsaturated cyclohexenyl group bonded to a propane diol by a flexible linkage selected from the group consisting of alkylene, oxyalkylene, and alkyleneoxy linkages;

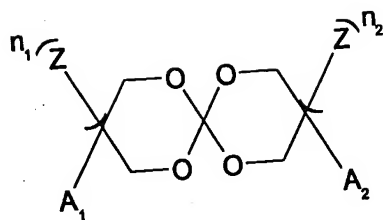
subjecting said alkyl substituted cyclo to transesterification with a tetra-alkyl-orthocarbonate to obtain an unsaturated 1,5,7,11-tetraoxaspiro[5.5]undecane; and

epoxidizing said unsaturated 1,5,7,11-tetraoxaspiro[5.5]undecane with an organic per-acid to obtain a 1,5,7,11-dioxiranyl tetraoxaspiro[5.5]undecane.

15. The product of the method of claim 14.

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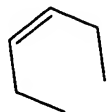
16. A compound of the structure:



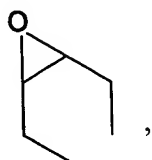
wherein,

A_1 and A_2 are each a hydrogen, alkyl group, the completion of a cyclohexenyl group

or one of the following structures

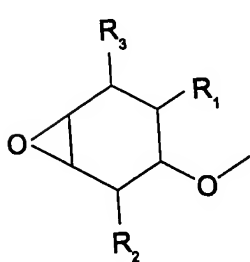
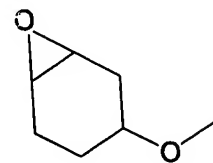
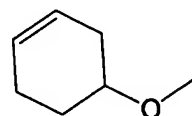
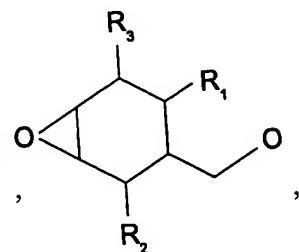
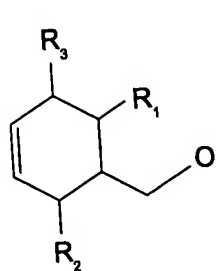
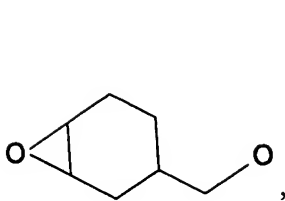
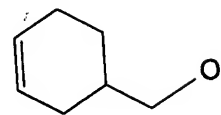
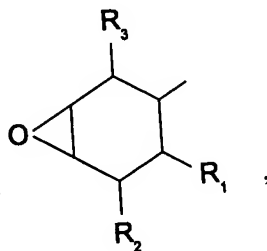
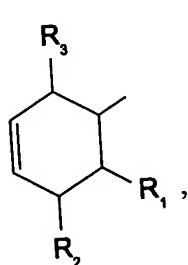
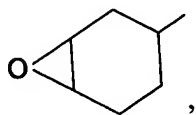
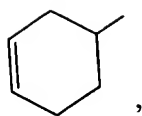


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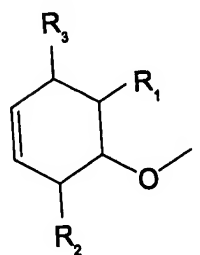


n_1 and n_2 are each 0 or 1,

Z is an alkyl group or is one of the following structures

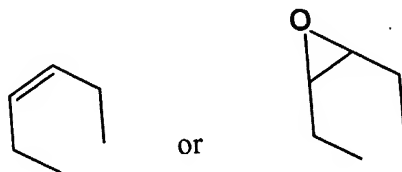


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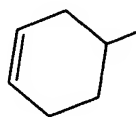
R_1 , R_2 and R_3 are each a hydrogen or alkyl group; and

$A_1 = A_2$ and $n_1 = n_2$, with the proviso that if A_1 and Z are both alkyl groups and $n_1 = 1$, then $n_2 = 0$ and A_2 is one of the following structures



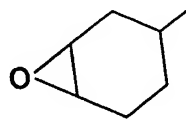
17. The compound of claim 16 wherein A_1 and $A_2 =$ hydrogen and n_1 and $n_2 = 1$

and Z is the following structure



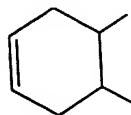
18. The compound of claim 16 wherein A_1 and $A_2 =$ hydrogen and n_1 and $n_2 = 1$

and Z is the following structure



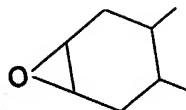
19. The compound of claim 16 wherein A_1 and $A_2 =$ hydrogen and n_1 and $n_2 = 1$

and Z is the following structure



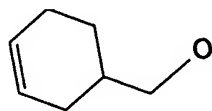
20. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



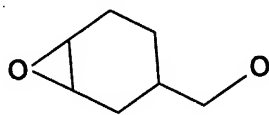
21. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



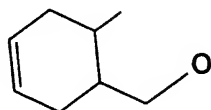
22. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



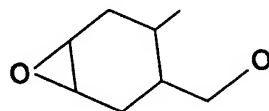
23. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



24. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

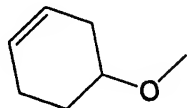
and Z is the following structure



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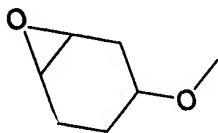
25. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



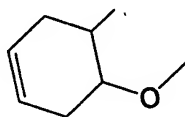
26. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



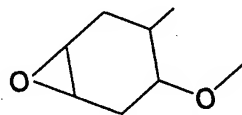
27. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



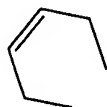
28. The compound of claim 16 wherein A_1 and A_2 = hydrogen and n_1 and n_2 = 1

and Z is the following structure



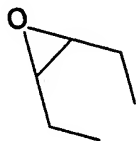
29. The compound of claim 16 wherein n_1 and n_2 = 0 and A_1 and A_2 are the

following structure



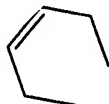
30. The compound of claim 16 wherein n_1 and $n_2 = 0$ and A_1 and A_2 are the

following structure



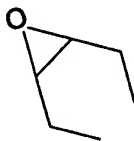
31. The compound of claim 16 wherein $n_1 = 1$, A_1 and Z = ethyl groups, $n_2 = 0$ and

A_2 is the following structure



32. The compound of claim 16 wherein $n_1 = 1$, A_1 and Z = ethyl groups, $n_2 = 0$ and

A_2 is the following structure



33. The compound of claim 16 wherein R_2 and R_3 are each hydrogen and R_1 is a lower alkyl group.

34. The compound of claim 16 wherein R_2 and R_3 are each hydrogen and R_1 is a methyl group.

35. A dioxiranyl 1,5,7,11-tetraoxaspiro[5.5]undecane selected from the group consisting of 3,9-bis(cyclohex-3-enylmethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(6-methylcyclohex-3-enyl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methyl]-1,5,7,11-tetraoxaspiro[5.5]undecane, 8,10,19,20-tetraoxatrispiro[5.2.2.5.2.2]henicosa-2,14-diene, 7,26-dioxatrispiro[bicyclo[4.1.0]heptane-3,5'-1,3-dioxane-2'2''-1,3-dioxane-5'',4''']-

bicyclo[4.1.0]heptane], 3,9-bis(cyclohex-3-enylmethoxy)-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[2-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis[(4-methyl-7-oxabicyclo[4.1.0]hept-3-yl)methoxy]-1,5,7,11-tetraoxaspiro[5.5]undecane, 3,9-bis(cyclohex-3-enyloxymethyl)-1,5,7,11-tetraoxaspiro[5.5]undecane, and 3,9-bis[7-oxabicyclo[4.1.0]hept-3-yl)oxymethyl]-1,5,7,11-tetraoxaspiro[5.5]undecane.

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